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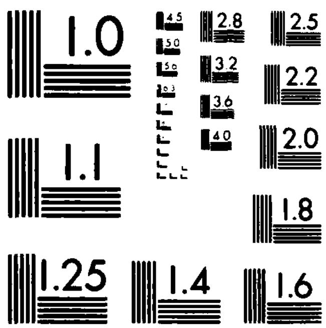

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FINAL REPORT

IVTS-CEV

GUNNERY TRAINER

CONTRACT: N61339-80-C-0104

CDRL SEQ. NUMBER A002

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(U) Simulation	(U) Target Acquisition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The IVTS project demonstrates the feasibility of applying to military training applications the video game technology developed for and marketed in consumer video games. The IVTS/CEV is a conceptual/breadboard-level classroom interactive training system designed to train Combat Engineer Vehicle (CEV) gunners in target acquisition and engagement with the main gun. The concept demonstration consists of two units: a gunner station and a display module. The gunner station has optics and gun controls replicating those of the CEV gunner station. The display module contains a standard large-screen color video

monitor and a video tape player. The gunner's sight picture/position, vis a vis the video frame, is controlled by gun control handle movements; sight picture movement rate vs handle movement is modeled on actual equipment characteristics. A series of video-recorded targets are presented on the monitor and viewed through the sight. A Digital Data Module compares sight aiming point (derived from electrical sight position sensors) and known-location of target on the monitor; target location data is coded on a video tape sound track. The Digital Data Module scores trainee performance and provides the instructor with a measure of trainee proficiency. Both fixed and moving targets were used to demonstrate the effectiveness of this approach. A concept evaluation conducted by the Armor-Engineer Test Board indicates that the system fully demonstrated its ability to yield a high degree of knowledge transfer.

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1.0 INTRODUCTION

1.1 General

This is the final report on IVTS/CEV concept development and test required under the provisions of Contract N61339-80-C-1014, CDRL sequence A002. The report covers development, concept evaluation, recommended changes and recommended application of the IVTS concept to other training requirements.

1.2 Development

The IVTS/CEV contract was awarded in July, 1980. Its purpose was to develop a classroom trainer for the M-728 Combat Engineer Vehicle main gun. The trainer has optics which replicates the actual weapon system. Optical scan is controlled by a simulated power control system that looks and feels the same as the M-728 vehicle. A series of targets are recorded on a video tape and are presented to the trainee on a television screen. Interaction is provided through Sander's Interactive Video Training System Digital Data Module (DDM). This module decodes target location data which is stored on the video tape and compares the target location to gunner aim point. The module scores the trainee and provides the instructor with a measure of trainee proficiency. Both fixed and moving targets were used to demonstrate the effectiveness of this system.

1.3 Concept Evaluation

Concept Evaluation was conducted at Ft. Knox, KY by the Armor Engineer Test Board. Results of the evaluation indicates that the system fully demonstrated its ability to transfer knowledge to trainees on M728 Combat Engineer Vehicle Gunnery tasks. A complete report is being submitted by the Board.[1]

1. Kimble, Capt Jerry D., and Will D. Hahn, Concept Evaluation Program of Interactive Video Tape System (IVTS) Evaluation for Gunnery Training on the Combat Engineer Vehicle, U.S. Army Armor and Engineer Test Board, Ft. Knox, KY, September 1981. TRADOC TRMS No. 1-CEP004.

PROGRAM REPORT

2.1 Introduction

The IVTS/CEV is an interactive training system which can be used to train the Combat Engineer Vehicles' (CEV) gunner in aiming and firing the main battery. The system can be divided into two major functional blocks: The DDM and the Applications Hardware.

The DDM functional block, which is similar for all IVTS type systems, is that portion of the system which performs all the computational tasks and the video overlay or video switching function. It contains the CPU, video tape recorder and the audio and video display electronics. Its major function are to read and store the digital data which has been previously recorded on the video tape, overlay computer generated graphics on the scenario scenes, receive real-time inputs from the applications hardware, score the student and control the functions required to make the IVTS a training system.

2.2 Applications Hardware

The Applications Hardware of the IVTS/CEV Training System is a simulator (mockup) of that portion of the CEV which is necessary to perform the training function. It is composed of:

1. Telescope Assembly
2. Power Control Unit
3. Gunners Switch Box
4. Helmet with Head Sets

2.3 Telescope

To position the gun on target the gunner in the CEV, after receiving range information via his headset, looks through a 8 power erecting telescope (8° field of view) and positions the correct range mark (which is inscribed on a reticle) over the target. He then fires one round and, after observing the position of the explosion relative to where he aimed, corrects for errors and fires a second round.

The student gunner, when using the prototype IVTS training system, looked through a 5.5 power non-erecting telescope at a 8° field of view. To correct for the non-errecting telescope the video scene was inverted.

2.4 Power Control Unit

The PCU (Power Control Unit) is the hand control unit which the gunner uses to control both the turret motion in azimuth and main battery motion in elevation. The PCU in the CEV controls motion by opening and closing hydraulic valves. The PCU in the CEV/IVTS, acting on the inputs to a variable speed motor unit, controls the simulation of motion by allowing the gunner to view different areas of the video scene with the telescope.

The PCU has the following general specifications:

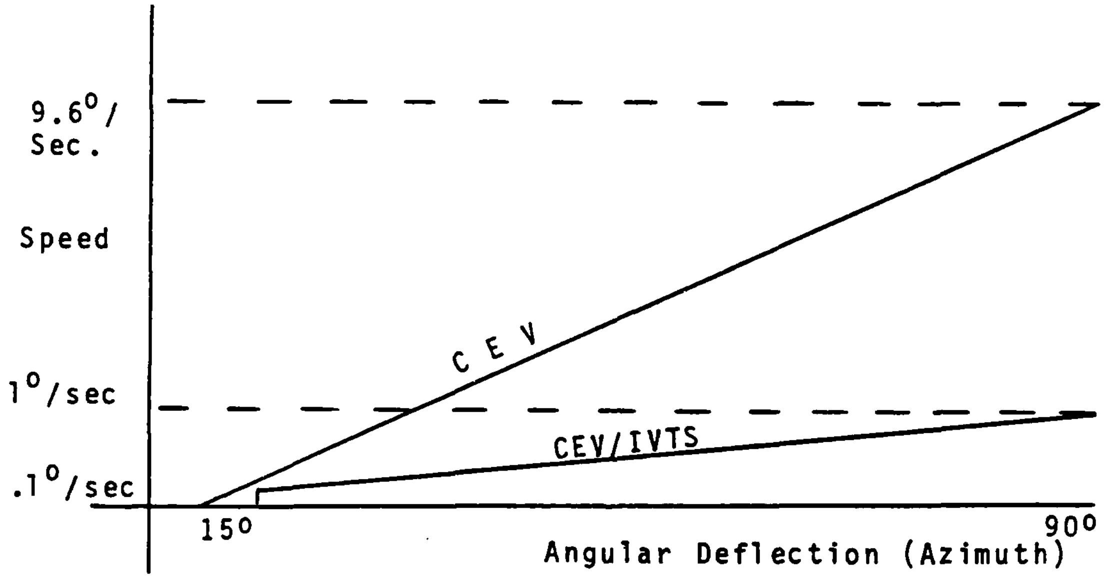
	CEV	CEV/IVTS
Operator Hand Motion - Azimuth	$\pm 90^{\circ}$	$\pm 45^{\circ}$
Operator Hand Motion - Elevation	$\pm 30^{\circ}$	$\pm 30^{\circ}$

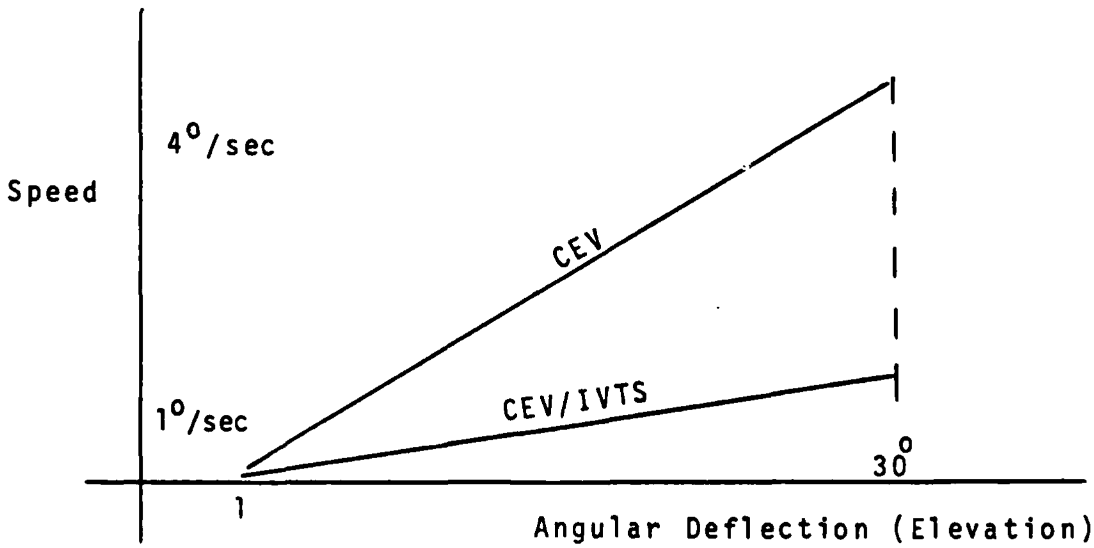
Figure 1 is a sketch of the view at the eyepiece of that portion of the CRT screen which the gunner will see. In the CEV/IVTS system the eyepiece will see 75% of the TV screen. With a eyepiece field of view of 8°, the TV screen will represent an 12 degree field of view in azimuth and a 9 degree field of view in elevation.

Speed/Deflection Curve

Speed - rotation velocity of turret or main battery

Deflection - Angular deflection of hand grip (PCU)



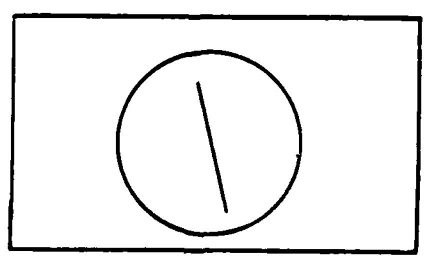


The physical motion of the telescope, relative to the screen, will be approximately 9 degrees in elevation. The 9 degrees has been selected such that the telescope can be elevated and depressed to the point where the "500" range marker on the reticle can be overlayed both at the top and at the bottom of the screen.

The center of the reticle is slewable to either side of the screen for 12 degrees of motion in azimuth.

IVTS/CEV system specifications are defined relative to the background scene on the TV screen. A typical example would be the minimum velocity of the turret in azimuth. This is not the actual rotational velocity of the physical telescope, but the relative velocity of the telescope scene across the TV screen.

The position input data signals from the PCU are potentiometer settings. The pots are mechanically connected to the two motion shafts within the PCU and their outputs (resistive value) are a function of the amount of angular deflection of the hand grips. These resistive values are used to drive the two motor control units which will be used to move the telescope around.



VIEW AT EYEPIECE OF TV SCREEN

FIGURE 1

2.5 Gunners Switch Box

The Gunners Switch Box on the CEV/IVTS system is physically similar to the CEV Gunner Switch Box. The box has three (3) switches and three associated indicator lights. The function of these switches are:

2.5.1 Elev/Trav Power

When this switch is turned on (up position), the gunner will be able to move the telescope across the face of the TV screen.

2.5.2 Main Gun

This switch will supply power to the indicator light above it. This is the only function that it will perform.

2.6 Helmet and Headset

It is assumed that each student gunner will use his own helmet. The audio inputs to the headset will be Tank Commander commands and instructions (audio portion of the video tape) and background explosions (computer generated audio).

2.7 Training Function

The CEV/IVTS application software is designed to perform the following training features:

2.7.1 Direct Fire Adjustment

The definition of Direct Fire Adjustment is as contained in Section 5 of the Field Manual FM5-12F 1/2 and 5-12F 3/4 "Solders Manual MOS12F CEV Crewman". The central theme in Direct-Fire Adjustment is the burst on target (BOT) method.

To perform the BOT method, either the gunner or the Tank Commander observes the round impact area to perform an aiming point correction.

2.7.2 After the first round, the gunner observes the impact area. If he sees an explosion he will perform a "BOT" correction. If he does not see an explosion he will assume that the TC will perform the "BOT" correction.

For a TC "BOT" the correction data will be displayed on the TV screen in the following format.

UP 100 (METERS)

LEFT 2 (MILS)

2.8 Typical Scenario - Stationary target at 400 yards

2.8.1 Scenario Sequence

Gunner hears video taped audio "Gunner-Two Rounds HEP - Bridge - 400 yards - Fire".

Simultaneously with audio (if gunner is looking into eye-piece of telescope) he will see a background scene. The target will appear within the 8 degree field of view on the TV screen. Using the Position Control Unit the gunner slews the main battery in both range and azimuth to position the correct range mark on the reticle over the target. The gunner waits until he hears the "up" command from the loader. The gunner fires one round and checks the position of the burst, corrects the error, and fires the second round.

Depending upon the number of rounds the TC has requested (Two Rounds HEP), the gunner may correct again for error and fire another round. After the gunner fires the number of rounds specified by the TC, the trigger switch is locked out until the start of the next scenario. At this time, "Cease Fire", the number of rounds fired and the number of hits will be displayed on the screen.

2.9 Target Engagement

The second function of the CEV/IVTS training system is to increase the proficiency of CEV crews in typical combat demolition tasks. The typical combat demolition tasks include destruction of road blocks, barriers, concrete bunkers and enemy-held strong points in build-up areas.

Target Types	Impact Areas
Multispan Bridges (more than one support pier)	Low on the support piers
Single Span Bridges (no support piers in center)	Lowest center point of the span
Pillsboxes and bunkers	At the spertures
Tunnels	First round on either side of the entrance
Buildings	Low and at center
Log Crib	Low and at center
Moving target	On target
Tetrehedron	On target

2.10 Scenario Types

2.10.1 In specifying the time to engage a target the following time assumptions are made:

• Time to load the main batteries	5 seconds
• Total Scenario Time	Variable
• Round Flight Time (Independent of Range)	2.5 Seconds

2.10.2 Single Impact Point

When the gunner fires at this type of target, there is only one specific point which will be classified as the attack point. Targets classified as Single Impact Points are buildings, moving targets, log cribs and tetrahedrons.

2.10.3 Multi-Impact Point

When the gunner fires at this type of target, there is more than one point (max. of 15) which will be classified as the attack point. Targets classified as Multi-Impact Points are single span bridges, multi-span bridges, pill boxes, tunnels, etc.

2.11 Scoring

In order to evaluate a student's performance and to give a competitive spirit, a student's performance score is displayed at the end of the training session. The training session can be stopped by depressing the required key on the keyboard.

The scoring method is to measurethe lapse time between "Target Visible" and "Trigger Pull" and between "Impact Symbol" and "Trigger Pull" and to compare this time against successful hits.

After a scenario tape has been completed, the following scores will be displayed:

$$\text{Average Time} = \frac{\Sigma\ \text{Time}}{\text{Total Rounds Fired}}$$

Where Σ Time is the total lapsed time the Total Rounds is the number of rounds fired. In calculating the storing each individual lapse time the system resolution will be to approximately 1/8 of a second.

Hits $= R_H$

Rounds $= R_M$

Final Score

In order to have a final score which will increase in value the faster and the more accurate a gunner fires the main battery, the system will calculate the following final score:

$$\text{Score} = \frac{R_H}{\text{Requested \# of First Round Hits}} \bullet \frac{\text{Total Rounds Fired}}{\Sigma\ \text{Time}} \bullet K$$

Where Requested is the number of rounds which the tank commander requested and K is the constand to keep the score an integer.

$$\text{Score} = \frac{K}{\text{Time for Scan}} \qquad \text{where } K = 0 \text{ for miss}, \quad K = 600 \text{ for hit}$$

The reason for the two terms "requested minus # of first round hits" and "total rounds fired" is to account for the case of the gunner not firing all the required rounds during one scenario.

For a typical thirty minute tape, the score could range from 0 to 1536 (60 hits, average time 5 seconds and K - 128).

2.12 Video Tape

2.12.1 Audio

The following types of commands will be recorded on the audio portion of the video tape.

Gunner - One Round HEP - Target Type - Range - Fire
Target Type, Range and Number of Rounds will be variable

2.12.2 Video - Video portion of the tape will contain all the background scenario information.

2.13 DDM Digital Data

Seven eight bit data words can be stored (in triple redundancy during each video field.) For the CEV/IVTS the following data words will be stored. (For a complete explanation of data type and format see Appendix J).

2.13.1 Start of New Scenario

This identification word is recorded at the start of each new scenario.

2.13.2 Number of Impact Points

This eight bit word specifies the number of static impact points.

2.13.3 TC/Gunner BOT (One bit)

This bit will specify whether the tank commander or the gunner will perform the burst on target function. For tank commander BOT the explosion symbol will not be displayed on the screen.

2.13.4 Windage and Cant Factor - (Seven bits plus sign)

This factor will be used to simulate windage and cant errors. The algebra value of this byte will be added to the azimuth coordinate of the impact point. This factor is necessary to simulate windage, cant and gun/telescope misalignment.

2.13.5 Range Data - (Eight bits)

The horizontal height of the reticle in the CEV/IVTS system is approximately 50% (50.5%) of the horizontal height of the TV screen. This means that the reticle can be resolved into 90 spot positions or approximately 10 meters. All impact points (multiple impact point scenario) will have the same range.

2.13.6 Number of Rounds Required (Four bits)

Each scenario can have up to fifteen (15) rounds.

2.13.7 Impact Number and Position

Three eight bit words within a specific data block will be used to specify impact point number and its X & Y coordinates.

2.14 Video Display

The following will be displayed on the TV screen.

2.14.1 Background Scenario

The background scenario will be prerecorded on video tape and played back through the system on the TV screen.

2.14.2 Impact Explosion/Miss

When the gunner fires the main battery this symbol is displayed on the TV screen (gunner sees it through the telescope) at the impact point. The impact point is the point where the gunner is pointing his gun (this point will be modified by both the Cant/Windage factor and the range correction factor). Depending upon type of tape, this symbol will be displayed for one or two seconds after impact.

2.14.3 Cease Fire

After the gunner has fired the required number of rounds the following information will be displayed on the screen:

Cease Fire

Rounds 2

Hits 1

The number of rounds and the number of hits will be for the just completed scenario only.

2.14.4 Tank Commander Command

If the scenario is a TC/BOT type, the adjustment command will be displayed on the TV screen after the Impact Explosion symbol has been removed. The displayed format will be

UP 100 (METERS)
LEFT 2 (MILS)

2.14.5 Score

After the training session has been completed the final score will be displayed. The displayed format will be

Average Time - Seconds
Rounds -
Hits -
Score -

2.15 System Software Flow

2.15.1 System Initialization Time

At system initialization time the following constants may be changed.

2.15.1.1 Hit Resolution Constant

The Hit Resolution Constant defines the area around the impact point into which the rounds must land for the student to get a hit.

2.15.1.2 Impact Symbol Display Time

Impact Symbol Display Time variable, will be set up at initialization time. This variable will range from zero to approximately four seconds in 16.7 millisecond increments (8 bits).

2.15.1.3 Score Initialization

At initialization time the gunners scores will be set to zero.

2.15.1.4 Initial Tape Position

In operating the system as a training device it is not necessary to start the video tape at the beginning. It is possible to start the training session at any part of the tape.

2.15.2 Digital Input Data Flow

The start of a new scenario is when the gunner hears the tank commander's voice on the audio portion of the tape. To the microprocessor, the start of a new scenario is when the microprocessor receives the "Start New Scenario" data block.

The sequence of data blocks is:

1) Start of New Scenario
2) Target position and number
3) Target position and number (if required)
4) Target position and number (if required)
5) Target position and number (if required)

Depending upon the software configuration within the tape annotator, range and target position data may be sent only once or continuously transmitted. Each time the microprocessor receives range or position data, it updates these words. For a stationary target, the range and position data should be constant throughout the scenario. For a moving target it can vary.

Upon receiving the "Start of New Scenario" data block, a software timer is started. After approximately five seconds (the time it takes for the loader to load the first round), the software outputs in "up" command (via the noise generator) and starts the lapse time counter (at score calculation time the value of the lapse time will be divided by the number of fired rounds to determine the "Average Time").

The gunner hears the "UP" command and, knowing that the main battery is loaded, fires the first round.

Upon sensing the trigger input, the program outputs an explosion (via the noise generator) and reads the X and Y pot positions from the telescope position potentiometers.

The program now performs the following functions:

1) Update the stored lapse time
2) Increments the number of rounds fired
3) Add correction factors (function of actual range) to the X and Y telescope coordinates
4) Add cant/windage factor to corrected X telescope coordinate. The result of these additions is the displayed impact point.
5) Using the Hit Resolution Constants, compare the displayed impact coordinators with the target coordinators for a hit or a miss (a comparison must be made for each target point).
6) Display explosion symbol for the length of time specified by the Impact Symbol Display Time, update score data, lockout trigger switch, check to see if this is the last round to be fired. If this is the last round to be fired display "Cease Fire" and "Score".
7) For a Gunner/BOT wait five seconds (time for reload) and output a "UP" via the noise synthesizer. Arm the trigger and wait for the second trigger imput. Upon receiving a trigger signal repeat steps 1 through 7 except this will be the last round.
8) For a TC/BOT, calculate the required BOT correction to the nearest 25 meters and one mil increments. Wait three seconds (impact display time and time for the TC

to make a "BOT" correction) and display the correction on the TV screen in the following format for two seconds:

SHORT RIGHT 2 ADD 200

Arm the trigger and wait for the second trigger imput. Upon receiving a trigger signal, repeat steps 1 through 7.

9) Moving target - TC/BOT will never be performed on a moving target.

2.15.3 End of Session

To end the Training Session and display the final score the instructor will depress a key on the keyboard.

2.16 TV Sweep Accuracy

The CEV/IVTS System uses a single turn, 0.5% linear, 10K potentiometer to determine where the telescope (center point of the optical reticle) is pointing relative to the screen on the TV. The system software taskes the setting of the potentiometer (resistive value) and converts it to a number between zero and 255.

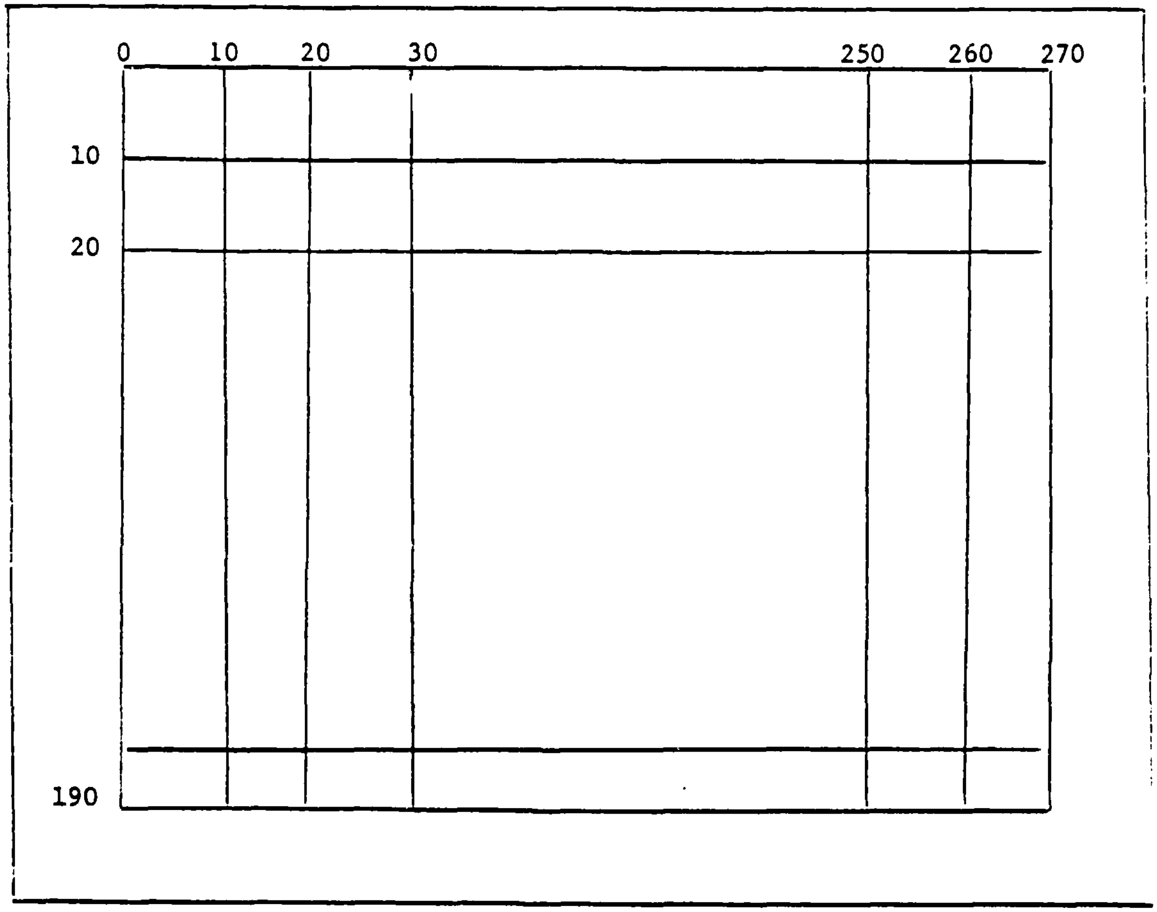
To calibrate the system, the centerpoint of the optical reticle is positioned over the center of the TV screen, and the software reads the setting of the potentiometer. At center screen, the settings of the potentiometer should convert to approximately 128. As the telescope is moved away from the center of the screen, there will be a linear relationship between the converted settings of the potentiometer and the distance the center point of the reticle has moved.

Figure 1 is a drawing of the pattern which a Sanders diagnostic can display on the TV screen. In the Apple computer, horizontal position (Azimuth) is divided into 270 spot positions across the face of the TV screen and vertical position (gun elevation or range) is divided into 190 positions. One part of the diagnostic is a BASIC program which will display these lines.

The other part of the diagnostic is a BASIC program which reads the setting of the pots, converts it to a number between 0 and 255 and displays the number (X & Y coordinates of where the 500 meter mark on the reticle is pointing) on the face of the screen.

Table 1 is a list of the results of the diagnostic when it was run for the On-Site Demonstration for the X direction (Azimuth)

Column one is the line number.



TV SCREEN

FIGURE 1

Column two is the converted output of the potentiometer (0 to 255).

Column three is the normalized azimuth counter result after the seven is subtracted from column three.

Column four is the deviation from a normal increment of nine (9) units.

Table II is the results of the diagnostic for the Y direction (range).

The results of both tables show that the TV set used had an unlinearity of less than three percent in both X and Y. The size of the error is within the acceptable error range for a TV type training system.

This linearity error is independent of whether the system used a TV set or a TV monitor. The only thing gained with a TV monitor would be the clarity, etc. of the picture.

TABLE I - AZIMUTH

LINE #	AZIMUTH COUNTER	NORMALIZED AZIMUTH COUNTED	DEVIATION
o	7	0	0
10	16	9	0
20	25	18	0
30	35	28	+1
40	44	37	+1
50	53	46	+1
60	62	54	0
70	72	63	0
80	81	75	+3
90	91	84	+3
100	100	93	+3
110	109	102	+3
120	118	111	+3
130	127	120	+3
140	136	129	+3
150	144	137	+2
160	152	145	+1
170	161	154	+1
180	169	162	0
190	177	170	-1
200	185	178	-2
210	194	187	-2
220	203	196	-2
230	211	204	-3
240	221	214	-2
250	229	220	-5
260	236	229	-5
270	245	237	-6

TABLE II - RANGE

LINE #	RANGE COUNTER (Y)	NORMALIZED RANGE COUNTER	DEVIATION (LINE 1-LINE 2) (10)
0	16	0	
10	29	13	+1
20	41	26	+2
30	53	37	+1
40	64	48	0
50	75	59	-1
60	88	72	0
70	99	83	-1
80	112	96	0
90	124	108	0
100	136	120	0
120	147	131	+1
120	159	143	+1
130	171	155	+1
140	183	167	+1
150	196	180	0
160	208	192	0
170	219	203	+1
180	231	215	+1
190	244	228	0

2.17 Video Tape Data Recording Error Rate

In order to make the software resident in the DDM the same for all scenarios, constants, which vary for each scenario, e.g., number of targets, their position and range, etc., are stored on the non-viewable section of the video recording. This data is stored as eight bit digital words.

Each word is recorded three times (triple redundancy) with parity during each video field. Each block (the seven digital words within a video field) is recorded on two different video fields. During system operation, the data is read and if a parity error is sensed, majority voting determines which is the correct data.

Throughout the development phase of the CEV/IVTS system, various diagnostics were run to determine the recording error rate. The final conclusion was that if the data was recorded correctly, there would not be any problems in the data retrievel. The times that there were problems in reading the data, it was attributed to a bad initial recording.

SECTION 3

3.0 Videotape Cassette/Videodisk Comparison

The purpose of this paragraph is to describe and compare videotape recorders/players and videodisk systems. It should be understood that day-to-day developments may alter conclusions reached in this paper.

3.1 Videotape Cassette Recorder/Players

Videotape recording and playback are based on four (4) principals:

First; a videotape is just a long thin magnet formed from an iron-oxide powder glued to one side of a plastic tape. The strength of a magnetic can be varied along its length, a principal that permits the magnetic strength along the length of videotape to be varied.

Second; the magnetic field of a wire wound solenoid can be varied. The strength of this magnet is proportional to the magnitude of the current in the solenoid wire.

Third; if the videotape is placed in the solenoid created magnetic field it will become magnetized. If the current in the solenoid is varied as the videotape is moved across the solenoid surface the magnetism of the videotape will be varied. To record video on a magnetic tape the recording head is the solenoid and the current in the solenoid wire is the information to be recorded.

Fourth; the reverse of the third principal is also true. If a videotape which has recorded information in the form of magnetism is pulled past a head or solenoid a current will be induced into the solenoid wire which represents the magnetic pattern on the tape. Playback is achieved in this manner.

3.2 Record/Playback

The two main functions of a videotape cassette recorder/player is recording and playback of a video signal. The input video signal must be the industry standard and the format used to record must be used in playback. The helical scan videotape recorder/player has become the standard machine of the non-broadcast industry. While there are different models and formats the basic principals are the same in all helical scan machines. There are certain fundamental points which affect the operation of videotape recorder/player.

- Slant Track Recording

A video picture or frame is composed of two interlaced fields. The fields are generated sixty times per second and are composed of 262.5 lines which begin at the upper left of the picture tube and ends at the lower right. The field is shifted and repeated providing an interlaced video frame which is composed of 525 lines. Each video field is recorded on a single track which slants across the tape at approximately 60°.

- Servos

The rotating helical scan heads of the video cassette recorder/player are mounted on a motor-driven shaft which also drives a device that generates pulses to indicate the position and speed of the rotating heads. When recording, a constant speed motor drives the tape and these head reference pulses are recorded evenly spaced along a control track on the video tape. When the tape is played back the control pulses are detected and compared to the rotating head pulses so that the servo system can position the head correctly in relation to the slant track which is the recorded video field.

- Tape Tension

Tape tension must be the same on playback as it was in record. If the tape stretches or sags the heads will not scan properly resulting in synchronization and picture quality problems. Atmosphere conditions as well as machine problems can affect tape tension.

3.3 Videodisk

There are at least four incompatible videodisk formats which are currently available or will be available in the near future. The formats to be discussed are:

- MCA/PHILLIPS Optical-Laser System
- Thomson-CSF Optical-Laser System
- RCA Capacitance System
- Matsushita/JVC Very High Density (VHD) Capacitance System

3.3.1 MCA/PHILLIPS Optical-Laser System

Television picture and sound information are encoded on the surface of an optical videodisk in the form of very closely spaced tracks of microscopic pits. A standard optical videodisk contains 54,000 such tracks, each corresponding to a single television frame. Spinning at 1800rpm, the MCA/PHILLIPS disk provides 30 minutes of playing time.

The optical videodisk starts out as a precision ground and polished glass master. Video and sound signals are placed on appropriate PM carriers and combined to form a single PM signal that is used to modulate a laser beam focused on the photoresist-coated master.

Once the master has been exposed and developed, the surface is metalized with a copper coating and subsequently nickel plated to produce a "mother". This mother is used in making additional copies by the standard production techniques of injection molding or compression molding.

To playback a MCA/PHILLIPS optical videodisk a helium-neon laser beam is focused on the surface of the disk and is either weakly or strongly reflected depending on the presence of a pit at the spot where the beam is focused.

The system used to play the videodisk is mounted on a precision mechanical slide that moves the disk to provide course tracking during normal play and slow motion, and for fast forward and reverse searches. Exact tracking of the micropits by the laser spot is achieved by a servo-controlled tracking mirror. During freeze-frame viewing, this tracking mirror is used to repeatedly switch the laser spot back to the beginning of the frame track during the vertical blanking period.

3.3.2 Thomson-CSF Optical-Laser System

To say that the Thomson-CSF videodisk system is the same as the MCA/PHILLIPS system is unfair and not intended. However, for the purpose of this paper the video display services to be provided by each system may be said to have a high commonality. The significant differences deal with format and a unique feature provided by the Thomson-CSF system. Both systems have a very shallow depth of focus which has the advantage of placing dust and scratches on the disk surface out of focus. This feature is used to an advantage in the Thomson system which uses a transparent disk. The disk is read by transmission. The laser beam is diffracted when it passes through the micropits and is read by photo-electric detectors. With this system either side of the disk can be read by refocusing the laser beam.

3.3.3 RCA Capacitance System

The disks used in RCA's capacitance videodisk system are grooved in much the same way as ordinary long-playing sterophonic records. The grooves are much closer, however, about 10,000 to the inch, or about 40 times closer than in an audio disk, and the disk is made from conductive vinyl plastic. Spinning at 450rpm each disk provides 60 minutes of playing time per side.

The very fine spiral groove guides a diamond stylus that has a thin metal electrode on its trailing face, and the video and sound information are contained in depressions in the bottom of the groove. In contrast to an audio disk, the only function of the stylus is to track the groove and support the electrode on its face. Relying on a grooved disk eliminates the need for the elaborate tracking and servomechisms required in the optical-laser videodisk system.

This feature also limits the utility of the disk to those applications which do not require random or controlled access to individual frames or scene sequences.

To produce the master from which a capacitance videodisk is made, video and sound signals are combined in a way similar to that used in the optical-laser system. Instead of modulating a laser beam, however, the signal is used to drive a piezo-electric diamond cutter that simultaneously cuts the tracking groove and impresses the PM signal into a copper master. Nickel mothers are then made from the copper master as with optical videodisks. Either compression or injection molding can be used to make disks, although injection molding is preferred for the carbon-loaded vinyls needed in conductive disks.

3.3.4 Matsushita/JVC VHD System

The Matsushita/JVC video high-density (VHD) system uses the same capacitive detection scheme as RCA's, however, the disks are quite different. The disks resemble those used in the optical-laser system and are made in much the same way - from laser-exposed photo-resist-coated glass masters. In contrast to the optical system where the pits are sensed by a reflected or diffracted laser beam, the VHD system uses a conductive vinyl disk and senses the pits capacitively. Since there are no grooves in the disk to guide the stylus, additional pits are located alongside the main signal to provide tracking signals to the electrode stylus. These signals are used to drive the servo-controlled arm that carries the stylus. Capacitive pickups can resolve signal elements significantly smaller than the wavelength of light. The VHD system puts one hour of television programming on one side of a 10-inch disk.

It is claimed that the grooveless disk gives the VHD system at least the same flexibility as the optical-laser disk system with less complexity. Slow motion, fast foward and reverse, freeze frame and random access are purported to be possible with this system.

3.4 Comparison of Videotape to Videodisks

An objective analysis of the values of one system over another is almost impossible. While the videodisk has many desirable features not readily available in non-broadcast tape recorder/players consumer demand and competition in the Educational Videotape area has resulted in the evolution of videotape machine features. External processor control, random frame access and freeze frame (pause) are now or will soon be available in Sony and Panasonic machines. Conversely it is reasonable to assume that low price optical disk mastering system may soon be offered. This constant evolution of product features and a certain emotionalism exhibited by advocates of one or the other system tends to confuse and reduce the value of any analysis.

3.5 Comparative Discussion

	Optical Videodisk	Videotape
• Pre-Mastery	Normally requires storyboard, shooting, editing, captions, narration to develop a videotape or film master.	Same
• Mastering	High cost on special equipment at central industrial location. Reports indicate that it can take up to one year from the beginning of the pre-mastering phase to the completion of an acceptable master.	Completed in Pre-Mastering phase
• Reproduction	Rapid, low cost with constant level of quality.	Slow, relatively high cost, and not the consistant quality of an optical videodisk.
• Picture Quality	Excellent	Not as good as an optical video disk. Quality also varies as a function of the individual studio equipment.
• Computer Control (Programmable Play)	Yes by both on-board or external computers	Yes, only systems with external computer interface have been observed. It is assumed that machines with on-board computers are now or will soon be available.

	Optical Videodisk	Videotape
• Frame Random Access	Yes, to a specific frame with maximum search times ranging from 2 to 4 seconds	Yes, however maximum search times can be 10 to 20 times that of the videodisk.
• Freeze/Pause	Yes	Yes
• Frame Advance (Step)	Yes	Yes
• Slow Motion	Yes	Yes
• Search Forward and Reverse (Video Image on Screen)	Yes, approximately 10 times normal	Yes, approximately 9 times normal
• Computer Graphics Overlay	Yes and the quality of the composite sync signal simplifies task of computer to video signal phase lock	Yes, however, tape stretch and other problems require that computer to video signal phase lock circuitry be rather more sophisticated than for the videodisk
• Update or change of video frames/data	Must go through Mastering cycle for any change where all of the tutorial information is imbedded in the disk. In those lessons where the video disk provides the visual media and a computer provides tutorial information then a change in program can delete display of undesirable frames and the computer can substitute correct tutorial information while a new disk is in the mastering process.	Can be edited locally

3.6 Comments

As can be seen any judgement on the utility of either system would have to be based on the intended application. It is practical to consider videotape in any training system development phase even if a disk will be the ultimate video storage medium as long as the unique features of the disk are not an essential part of system parameters. In many instances where there is a low target population the videotape is probably as cost effective as the videodisk. Conversely, where the target population is high the disk is always the best choice as is the case where rapid frame accessability is necessary.

SECTION 4

4.1 Recommended Changes

Sanders' recommends that the following changes be implemented in the pre-production model of the CEV/IVTS system:

4.1.1 Decrease physical size of the system as shown in Figure 1.

4.1.2 Incorporate a 9" color monitor as part of the system. This adaptation simplifies the optics system, increases transportability, ensures alignment between optics and visual scene and reduces surface area requirement for system set-up.

4.1.3 Replace Apple computer with more rugged and reliable 8085 based computer system. The Apple computer was selected to ease software development and on-site test and debug. While this computer is an excellent tool for a professional it will not survide constant transport and rough handling without extensive modification. Sanders' 8085 based system is designed to meet military requirements and will cost less than the Apple when produced in number.

4.1.4 Implement machine gun training capabilities. Tracer graphics will be implemented in software which responds to the machine gun switch selection.

4.1.5 The thickness of the reticle lines in the optical system should be decreased by 50%.

4.1.6 Install a head rest which moves with telescope. The head rest should position the students eye for the same eye relief as the actual system.

4.1.7 Elevation controls should be loose - decrease torque by 50%.

4.1.8 Azimuth control should have zero torque at zero and 75% less torque, over remaining travel (when the azimuth control is activated it should oscillate to simulate actual equipment).

4.1.9 Dead zone (hand control) in both azimuth and elevation is approximately ± 15 degrees.

4.1.10 Install a second audio input such that the instructor (tank commander) can use a helmet or microphone for scenario control instead of using the audio on the VTR. Provide a switch to permit the instructor to select either source.

4.1.11 Make calibration 600 meters instead of 500 meters (bore sighting is done at 600 meters in vehicle).

4.1.12 Display the correct impact point on the target. This can be implemented by allowing the student to request that a small circle ("O") could be overlayed on the scene at each impact point.

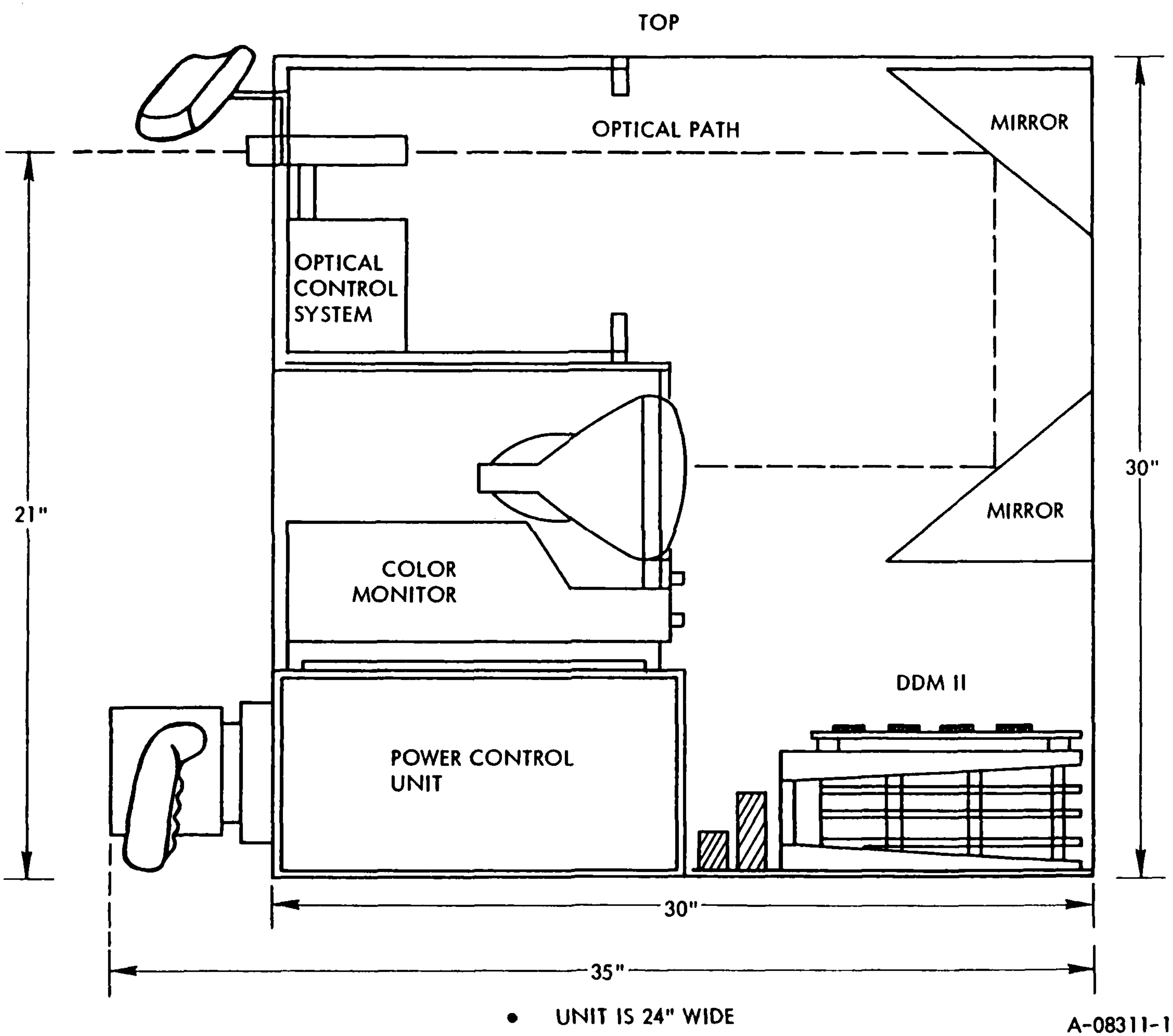
4.1.13 Display and range (in meters) and cant (in mils) for each impact point by student request.

4.1.14 Use audible sounds for student feedback to indicate proximity of burst to correct impact point. One pip indicates outer edge of acceptable impact zone, two pips indicates half distance between outer edge and perfect hit and three pips indicates perfect hit.

4.1.15 Replace the potentiometer position detection devices with an optical raster scan line position detection system. Currently the position of the optics relative to the scene is electromechanically measured using potentiometers. This scheme requires that the optical system and the video display be critically aligned; a condition that will be hard to maintain in a transportable training device. By using an electro-optical scheme the system measures the aim point by optically determining alignment to the CRT raster lines doing away with the need for critical mechanical alignment.

4.1.16 Enhance audio simulation to provide firing sounds which are closer to actual system.

4.1.17 Enhance audible "up" report by loader.



IVTS-CEV W/Monitor

5.0 Recommended Application of IVTS Technology

Follow-on application of IVTS technology to military training can include any system which requires a high quality visual representation of real-world target parameters and concurrent interaction between the trainee and the scene. The following two systems are considered prime candidates for this application. The M60 Machinegun and follow-on Squad Automatic Weapons (SAW) don't have a training system which provides effective feedback on the fundamental skills of position and grip, sight alinement and sight picture, trigger manipulation and zeroing the weapon. Mortar indirect fire trainers are normally configured for institutional classroom use and as such are not available at unit level. An application which provides observed fire training at unit level should also be considered.

5.1 Machinegun Training

FM23-67 indicates that M60 Machinegun training is conducted on basic and transition ranges where fundamentals of machinegun marksmanship are learned, followed by field target firing courses where the individual applies these fundamentals against typical battlefield targets. Maintenance of proficiency at unit level is essentially the same as indicated above except that ammunition expenditure on basic and transition ranges is reduced.

Ammunition expenditure to accomplish this training is as follows:

MARKSMANSHIP TRAINING	ROUNDS
• Basic Range (10 meters)	336
• Transition Range	276
• Field Target Courses	450
TOTAL	1062

PROFICIENCY FIRING	ROUNDS
• Basic Range (10 meters)	108
• Transition Range	138
• Field Target Courses	550
TOTAL	796

5.1.1 Marksmanship Training

Basic marksmanship training, both bipod and tripod mounted gun, is conducted on a 10 meter range utilizing an 81 x 122 centimeter target which provides scoring spaces for eight fixed fire exercises and two traversing and searching exercises. The target when viewed from 10 meters subtends an angle of approximately 7 degrees. Familiarization training is conducted on 800 to 1100 meter ranges which have individual firing lanes that subtend an angle equal to 5.6 degrees. To duplicate either training course in a simulator the same target geometry would be required.

5.1.2 IVTS Application

Sanders suggests that the 10 meter target and an individual transition course firing lane lend themselves to presentation on a video screen. A TV monitor which has a CRT with a horizontal measurement of 35 centimeters (19" diagonal) will present either target course with a high degree resolution and will support trainee interaction. An exact reproduction of target geometry as seen on the 10 meter range, is achieved when the trainee eyepoint is located 2.8 meters from the TV monitor. The same approach will apply to the familiarization course, however, the resolution is higher because of the smaller angle subtended at the CRT.

5.1.3 Physiological Requirements

The next consideration is an M60 Machinegun simulator which supports training in the application of the marksmanship fundamental skills of position and grip, sight alinement and sight picture, trigger manipulation and zeroing the weapon. These capabilities must be inherent to the simulator while it is replicating to a high degree of fidelity characteristic sounds and recoil of the actual weapon during firing exercises. It is recommended that an actual M60 Machinegun be demilitarized and modified for this purpose. These weapons are available for approximately $3,000 each.

The physiological sensation (kick) producted by recoil is a function of recoil velocity or energy developed when the gun is fired. For the purpose of this paper the term recoil refers to "Free Recoil" which is the velocity or energy developed by the gun alone with no other mass added to oppose rearward motion. It is expected that additional weight and resistance to include either the tripod or bipod will be present and reduce free recoil velocity and energy by some unknown quantity.

- Recoil Velocity (no muzzle brake)

$$\frac{(150 + 1.75 \times 50)\ 2729}{7000 \times 23} = 4.03 \text{ feet per second}$$

150 = Bullet weight in grains
1.75 = Average effective velocity of powder gases
50 = Powder weight in grains
2729 = Bullet muzzle velocity
7000 = Grains in a pound avoirdupois
23 = Weapon weight in pounds

- Recoil Energy

$$.5 \times \frac{23}{32.16} \times 4.03^2 = 5.8 \text{ foot pounds}$$

Simulation of weapon recoil must also take into consideration recoil velocity rise time which in the case of the M60 is probably on the order of one millisecond or greater due to its weight. Sanders suggests introducing recoil (kick) directly into the barrel group, at the bipod yoke, for the bipod mounted weapon. Introduction of recoil at this point would ensure azimuth and elevation motion freedom and, if desired, permits extension of the recoil simulator mechanism to actuate the operating rod and provide automatic feed and ejection of belt feed dummy ammunition. Introduction of recoil for the tripod mounted gun would be at the gun platform and if desired the forearm assembly would be modified to provide access to the operating rod for automatic dummy ammunition feed and ejection.

5.1.4 Sound

Sound effects will be generated using a solid state device which produces high-quality electronically synthesized machinegun sounds. Sound would be presented to the trainee through a high fidelity head set which provides the additional feature of maintaining classroom noise at very low levels.

5.1.5 Aim Point Measurement

Measurement of trainee aim point, trainee feedback (bullet impact), and comparison of bullet impact to desired impact point are the essential elements necessary to complete the training system. Sanders' IVTS is designed to measure trainee aim point relative to a video screen (CRT or projection system) with a high degree of accuracy. The current system when presenting a scene with a 7^{o} field of view will measure aim point accuracy to within 500 microradians. A second generation IVTS currently in development will extend aim point measurement precision to within 250 microradians.

Feedback, which in the case of the M60 Machinegun would be location of a computer generated graphic bullet hole on the trainee aim point is accomplished to the same precision as indicated for aim point measurement. The computer generates and places a "bullet hole" at the proper time and location for each round fired until the entire burst is displayed. Machinegun bullet hole overlap may make it difficult to analyze trainee problems in application of proper position and grip, sight alinement and sight picture and/or trigger manipulation. However, by storing the impact location of each round fired in computer memory it then becomes simple to replay the burst in slow motion and if desired the graphic representation may be magnified in size on the TV screen. This type of feedback simplifies analysis of trainee problems and provides a graphic emphasis to these problems which cannot otherwise be determined. The computer would also provide feedback on machinegun training that uses beaten zone technique of fire. The beaten zone would be shown in the form of graphic representations in the impact area and would have the size and shape dictated by range and terrain. Here again bullet impact could be replayed in slow motion and magnified. Tracer simulation would be implemented through computer graphics and when coupled with the ballistic algorithm developed from Firing Table FT7.62-A-2 would provide effective feedback on bullet impact to the trainee.

Comparison of trainee aim point to desired aim point is accomplished by determining the location of the center of the desired point of impact to the same precision as the trainee aim point. Sanders' IVTS is capable of encoding the location of 2 or more dynamic (tanks, trucks, men) or 30 or more static (targets, fixed positions, etc.) points on each video scene. The IVTS eliminates the need for complex software and hardware synchronization during the comparison by recording the digital data, representing target Cartesian Coordinates, in the recorded video scene. Essentially, target location digital data is presented to the computer at the precise time the visual scene is presented to the trainee. Once the comparison is accomplished a score can be provided.

The Simulator approach outlined here is applicable to both 10 meter Basic and Transition Range Firing courses. Extension of training to include Field Target courses is reasonable and requires only that selected field targets be recorded on video tape or disc and presented to the trainee.

5.1.6 Cost Trade-Off

A classroom training device for the M60 Machinegun is a practical and necessary adjunct to any realistic training which provides real time feedback to the trainee. Currently, training in the fundamentals of machinegun operation is conducted on firing ranges which involves ammunition expenditure, transportation, POL, range operating and safety personnel. With the exception of the 10 meter course, feedback on trainee errors is limited or non-existant. For the 10 meter course, feedback is present, however, bullet hole overlap and the inability to determine the sequence in which the holes occurred place a heavy burden on instructor analysis of the trainee's inability to apply basic fundamentals.

If both the 10 meter Basic Range and Transition Range firing can be accommodated in a simulator which can provide necessary feedback, a significant saving can be achieved without changing the existing overall training program. Assume that at least 2000 individuals in the Army and the Marine Corps fire Basic and Transition Courses on a monthly basis:

858	Rounds
x 2000	Individuals
1,716,000	Total Rounds/Month
x .25	Cost of Round on 4:1 Tracer to Ball Mix
$429,000	Cost per Month
x 12	Months
$5,148,000	Annual Cost

As can be seen there can be significant savings in the machinegun or the Squad Automatic Weapons (SAW) training programs. This approach does not change existing firing courses which have proved successful over an extended period of time. It simply substitutes the medium that is used in the basic and transition training.

Sanders' classroom Interactive Video Training System when mated with an M60 Machinegun simulator as described herein will provide realistic training with graphic feedback that ensures easy analysis of trainee problems. Accomplished in a classroom, or for that matter any type of room, the training is not impacted by weather and requires only a common 110 volt 60Hz outlet. No other consumables are required.

High fidelity feedback provided by Sanders' IVTS ensures that when the trainee reaches a point in simulator training where he has qualified to actually fire an M60 Machinegun he and his instructors can concentrate on achieving a higher level of proficiency with a reduction in the expenditure of ammunition and other consumables.

5.2 Mortar Gunnery Training Device (IVTS)

5.2.1 Mortar Gunnery Problem

FM23-91 defines the mortar gunnery problem as follows:

"Mortars are normally emplaced in defilade to conceal them from the enemy. For the vast majority of targets placing the mortars in defilade precludes sighting the weapons directly at the target (direct lay), consequently, indirect fire must be employed to attack the targets. The gunnery problem is primarily the problem of indirect fire and the solution of this problem requires weapon and ammunition settings which, when applied to the weapon and the ammunition, will cause the projectile to burst on, or at a proper height, above the target. The steps in the solution of the gunnery problem are:

a. Location of the target and mortar positions

b. Determination of chart data (direction, range and vertical interval from mortars to target)

c. Conversion of chart data to firing data

d. Application of firing data to the weapon and the ammunition."

Location of the target is accomplished by the forward observer who follows a standard procedure sequence for processing a call for mortar fire. This sequence is as follows:

a. Target location

b. Preparation and submission of the call for fire

c. Adjustment of fire

5.2.2 Target Presentation

To perform target location the observer must have the target area in view and be capable of measuring (1) distance from his point to the target; direction to the target; target deviation from a known point (horizontal and vertical). Presentation of the mortar target area on a video screen is reasonable. Consider the observer's prime angle measuring device; the military binocular which has a horizontal and vertical mil scale etched on the reticle. These binoculars typically have a seven degree field of view. If these binoculars are located at 2.8 meters away from the TV monitor the video image field will fill the binocular field of view. Control of the recorded image field of view will now provide apparent range changes e.g., the diameter of a seven degree field of view at 1000 meters is 120 meters and a 4 meter target equals three percent of the FOV diameter. At 2000 meters the field of view diameter is 240 meters and the same target represents 1.5 percent of the field of view. By maintaining control of the diameter of the recorded scene field of view the observer is presented with a target area that can be measured using standard military binocular MIL scales. Target location within the target area scene can now be accomplished to the same precision as "real world" target location.

5.2.3 Estimation of Distance

Distance can be computed by measuring the angle from one point in the video scene to another with the binocular MIL scale. The trainee refers to a MAP training aid which indicates the lateral distance and he then applies the MIL relation formula. He may also estimate distance by establishing a yardstick in the video scene by asking the microcomputer to fire three rounds into the video scene with known range separation between rounds. The computer accepts the request from the observer and places a mortar burst symbol at the location requested for the first round and at timed intervals displays mortar burst symbols at the requested range separation points. The trainee may also wish to estimate range by timing sound. The microcomputer will always present the burst symbol and then delay the computer generated sound based on the simulated range to the burst point.

5.2.4 Measurement of Angles

The trainee can measure angles (both vertical and horizontal) within the video scene using the binocular MIL scale and map training aids which relate to the objects or terrain features within each scene.

As can be seen this approach will utilize existing training aids such as standard military binoculars, observed fire fans and coordinate scales. The high quality cues presented in the video scene will elicit necessary responses from the trainee and ensure training in target location. The call for fire may be processed through a manual fire direction center or a simulated Mortar Ballistics Computer, XM23.

5.2.5 Call for Fire, Manual FDC

The trainee observer performs target location and communicates his fire request to FDC trainees who use existing training aids to convert data contained in the observer call for fire to firing data and commands for the trainee's at the mortar section. If the training system includes a mortar with a sight unit that has been modified so that the IVTS microcomputer can monitor elevation and deflection settings then deflection and elevation data can be told directly to the mortar crew who in turn will set this data in the sight unit. It will be necessary to enter mortar charge data directly into the IVTS microcomputer through the keyboard. When the dummy round is dropped into the tube the computer detects this condition and computes time of flight, location of the simulated burst in the scene, and time of explosion sound. Scoring can be readily accomplished as the computer will know the actual location of the target point.

If the training system does not include a mortar that has been appropriately modified or if training of the mortar crew is not desired at this time the FDC trainee's may enter elevation, deflection and charge data directly into the IVTS microcomputer.

5.2.6 Call for Fire, Mortar Computer Ballistic's XM-23

The only requirement to implement this training as part of the IVTS system is to simulate the Ballistic computer front panel controls and indicators and connect the panel to the IVTS microcomputer. The IVTS microcomputer would perform all the ballistic computations and communicate appropriate indications to the trainee. In this case scoring would include proper operation of the Ballistic computer.

Adjustment of fire is accomplished when the trainee observer senses the impact of the mortar round computer generated burst in the video scene. It has been demonstrated that computer generated burst symbols overlaid on proper segments of the video scene will provide measureable feedback on range and azimuth displacement from the desired point of impact. Using his military binoculars the trainee measures the displacement and initiates an adjusted call for fire through the FDC. Training in adjustment of fire from an aircraft can also be implemented with Sanders' IVTS as it represents only a change in view of the target area. Video scenes taken from an aircraft can be coded to accomplish this training.

5.2.7 Training System

As can be seen the three major elements of mortar gunnery target location, fire direction, and application of firing data to the weapon can be trained in a classroom using a video based system which can score the trainees and provide realistic feedback.

With proper design the training system can be conditioned to support one or two elements of indirect fire team training. As an example the system should be capable of being conditioned to accept target location data and providing appropriate feedback to the trainee observer or FDC or mortar crew without the need for the other crew members.

ADDENDUM I

Field #	Data Block
1	Start of New Scenario
2	Blank (No Data)
3	Start of New Scenario
4	Blank
5	Static Data #1
6	Blank
7	Static Data #2
8	Blank
	.
	.
	.
p	Static Data #N
p+1	Blank
p+2	Start of New Scenario
p+3	Blank
p+4	Start of New Scenario
p+5	Blank
p+6	Static Data #1
p+7	Blank
p+8	Static Data #2
.	.
.	.
.	.
q	
q+1	Static Data #N
q+2	Blank
q+3	Static Dynamic
q+4	Static Dynamic
q+5	Dynamic Data #1
q+6	Dynamic Data #2
q+7	Dynamic Data #N

q+8	Dynamic Data #1
q+9	Dynamic Data #2
q+10	Dynamic Data #N
.	.
.	.
.	.
z-2	Dynamic Data #1
z-1	Dynamic Data #2
z	Dynamic Data #N
z+1	End of Scenario
z+2	End of Scenario
↑ 5 Sec Minimum Time Delay ↓	
1	Start of New Scenario
.	.
.	.
.	.

<u>Start of New Scenario Data Block</u>

BYTE 1 - Start of New Scenario Identification Word

Data Bit

0 - Identification Code LSB (1)

1 - Identification Code LSB (Ø)

2 - Identification Code LSB (1)

3 - Identification Code MSB (Ø)

4, 5, 6, 7 } Not Used

Byte 2 - Scenario Number

Bit 0 = LSB

Bit 7 = MSB

Byte 3 - This byte specifies the number of impact points or number of targets

Bit 0 = LSB

↕

Bit 7 = MSB

Byte 4 - This word will specify the range to the tartet in meters: the LSB will be equal to 10 meters

Bit 0 - LSB of Range
Bit 1 -
Bit 2 -
Bit 3 -
Bit 4 -
Bit 5 -
Bit 6 -
Bit 7 - MSB of Range

Byte 5 - This word will specify the windage and cant factor (Two's compliment) which will be algebracally added to the "X" coordinate of the telescope position point.

Bit 0 - LSB of Factor
Bit 1 -
Bit 2 -
Bit 3 -
Bit 4 -
Bit 5 -
Bit 6 -
Bit 7 - MSB of Factor

Byte 6 -

Bit 0 - Number of Requested Rounds - LSB
Bit 1 - Number of Requested Rounds - LSB
Bit 2 - Number of Requested Rounds - LSB
Bit 3 - Number of Requested Rounds - MSB
Bit 4 -
Bit 5 -
Bit 6 -
Bit 7 - This bit will specify whether the tank commander or the gunner will perform the "BOT" function. A "zero" specifies that it will be a gunner "BOT".

Byte 7 - Not used

Static and Dynamic Data Blocks

The Byte format for the "Static Data" and "Dynamic Data" blocks is the same the only difference (except for the bit which specifies a dynamic or static target) is their position in the code stream.

Byte 1 - Identifier Word

Bit 0 - Identifier Code LSB (1)
Bit 1 - Identifier Code LSB (∅)
Bit 2 - Identifier Code LSB (∅)
Bit 3 - Identifier Code MSB (∅)
Bit 4 - Target Number 2^4
Bit 5 - Target Number 2^5
Bit 6 - Target Number 2^6
Bit 7 - Target Number 2^7

Byte 2 - X Coordinate of Target Position

Bit 0 = LSB
Bit 7 = MSB

Byte 3 - Y Coordinate of Target Position

Bit 0 = LSB
Bit 7 = MSB

Byte 4 - This word defines the LS Nibble of the target number and whether it is a static or a dynamic target

Bit 0 - Target Number 2^0
Bit 1 - Target Number 2^1
Bit 2 - Target Number 2^2
Bit 3 - Target Number 2^3
Bit 4 - Not Used
Bit 5 - This bit defines whether the target is moveable or stationary. If this bit is "zero", it is a stationary target.
Bit 6 - Field Specifier Bit (Even/Odd)
Bit 7 - MSB of Y Position (2^8)

Byte 5 - Same as Byte 2

Byte 6 - Same as Byte 3

Byte 7 - Same as Byte 4

<u>End of Scenario Data Block</u>

The "End of Scenario" data block defines the end of the scenario.

Byte 1 - Identifier Word

Bit 0 - Identifier Code LSB (1)

Bit 1 - Identifier Code LSB (1)
Bit 2 - Identifier Code LSB (1)
Bit 3 - Identifier Code MSB (Ø)
Bit 4 -
Bit 5 -
Bit 6 -
Bit 7 -
NOT USED

Byte 2
3
4
5
6
Byte 7
NOT USED

Start Dynamic Data Block

This word will be used to indicate the start of Dynamic Data in the scenario.

Byte 1 - Identifier Word

Bit 0 - Identifier Code LSB (Ø)
Bit 1 - Identifier Code LSB (1)
Bit 2 - Identifier Code LSB (1)
Bit 3 - Identifier Code MSB (Ø)
Bit 4
Bit 5
Bit 6
Bit 7
NOT USED

Byte 2
3
4
5
6
Byte 7
Not Used

END

FILMED

8-83

DTIC